Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)
	)
CRITICAL CARE TELEMETRY GROUP	)
	)
Petition to Amend Part 15 of the Commission's Rules to Permit Operation of Biomedical Telemetry Devices at Power Levels Not In Excess of 5 Milliwatts on Vacant VHF and UHF Television Channels	)

To: The Secretary

PETITION FOR RULE MAKING

The Critical Care Telemetry Group ("CCTG") consists of Hewlett-Packard Company Medical Products Group ("HP"), Marquette Electronics, Inc., Pacific Communications, Siemens Medical Systems, Inc., and SpaceLabs Medical, Inc. ("SpaceLabs"). The CCTG includes virtually all of the companies located in the United States who manufacture low-power electrocardiogram ("ECG") devices and other low-power medical telemetry devices. CCTG hereby requests that the Commission, pursuant to 47 C.F.R. 1.401, issue, on an expedited basis, a Notice of Proposed Rule Making proposing to permit the operation of low-power, medical telemetry devices, on a Part 15 basis, on vacant VHF television channels in the 174-216 MHz band (channels 7-13) and on all vacant UHF television channels at power levels not in excess of five (5) milliwatts.[1]

In order to remedy as quickly as possible the present spectrum crisis facing medical telemetry devices, CCTG urges the Commission to refrain from seeking comments and reply comments on the instant Petition and, instead, to issue a Notice of Proposed Rule Making immediately. Dispensing with the comment and reply comment phase with respect to this Petition will not prejudice any interested party, as such party can comment fully on CCTG's proposal in the context of a Notice of Proposed Rule Making.

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[1] A copy of the proposed amendment to the Commission's Rules is attached hereto as Exhibit B.

As discussed herein and in the engineering statement accompanying this Petition (the "Engineering Statement," attached hereto as Exhibit A), the interference-free operation of these essential life-saving devices is threatened presently by a critical shortage of usable frequencies. Adoption of CCTG's proposal, however, would relieve that shortage, without risking interference to television reception, until such time as the Commission is able to allocate dedicated spectrum for medical telemetry operations, consistent with explicit Congressional intent.[2] Authorizing medical telemetry devices to operate on vacant upper VHF channels and on all vacant UHF television channels at power levels not in excess of 5 milliwatts would serve the public interest in the full and efficient use of the radio spectrum and in the provision of cost-efficient medical technologies to the health care communities.

Indeed, the Commission recognized the public interest benefits that flow from allowing medical telemetry devices to use television frequencies when it authorized operation of these devices on VHF channels 7-13 (174-216 MHz band) and on UHF channels 21-29 (512-566 MHz band).[3] However, the power levels permitted for operation of such devices on TV channels are so low that the interference-free operation of these devices is threatened in the 174-216 MHz band and precluded in the 512-566 MHz band. The Commission, therefore, should permit a slight increase in the power levels of medical telemetry devices, as proposed herein, in order to further the Commission's original purpose when it authorized the operation of these devices on television frequencies.

I. OVERVIEW OF MEDICAL TELEMETRY OPERATIONS

Medical telemetry devices are used in every major hospital and healthcare facility throughout the country. They enable healthcare providers to monitor continuously a variety of patient vital signs while still permitting those patients the freedom to move about in a limited area. In this regard, such medical telemetry devices shorten recovery time and reduce healthcare costs.

A. Design Constraints Applicable to Medical Telemetry Devices. The special requirements associated with monitoring patients' vital signs dictate the

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[2] See n. 10, *infra*.

[3] See 47 CFR 15.241 and 15.209 (a) and (g).

design features of medical telemetry devices. Among other things, the need for instantaneous, continuous and error-free transmissions precludes the use of communications techniques that can accept a certain level of error or an occasional garbled transmission that might fail to alert a monitoring nurse of a life-threatening situation or could distort vital signs.

Moreover, because medical telemetry devices are worn by patients whose conditions require constant supervision, it is essential that the devices be lightweight and protect patients from high levels of RF exposure. Low-power operation and other design features also preserve battery life and allow frequencies to be re-used by other low-power medical telemetry devices at nearby locations. Additionally, the antennas that monitor the patient units must be highly sensitive to receive signals from numerous patients within short distances from the antennas. Unfortunately, this also makes the receive antennas highly sensitive to interference from outside sources.

Finally, given the ever increasing concern in the United States regarding rising health care costs, systems have been and must continue to be designed to be relatively inexpensive to purchase and to allow for a long period of use without equipment replacement.

B. Demand for Multifunction Medical Telemetry Devices. While existing medical telemetry devices provide healthcare professionals with a wide range of patient data, there is ever-growing need in the medical community for more sophisticated monitoring devices that will provide additional data, such as three views of the heart (instead of the two views that most ECG devices now offer), as well as information relating to blood pressure, blood gas, and respiration. This second generation of enhanced medical telemetry devices will soon be made available to healthcare professionals.

II. MEDICAL TELEMETRY FREQUENCIES ARE SEVERELY CONGESTED

A. Frequencies Currently In Use. Because of constraints imposed by noise and propagation concerns at the lower ranges, and by battery life, product cost, and RF absorption by the patient at the upper ranges, medical telemetry devices must operate in a frequency band between 170 and 1,000 MHz. Within this range — either because of bandwidth requirements, service restrictions, overcrowding or

incompatible uses — channel availability generally is limited to secondary use of VHF channels 7-13 (174-216 MHz band) and UHF channels 21-29 (512-566 MHz band), authorized under Part 15, or the offset (or "splinter") frequencies in the 450-470 MHz band, authorized under Part 90.[4]

Of the monitors that operate on television channels pursuant to Part 15, practically all use the 174-216 MHz band, which has been reserved for the exclusive secondary use of medical telemetry devices. The hundreds of thousands of telemetry transmitters presently in use in U.S. healthcare facilities are divided fairly equally among the 174-216 MHz band and Part 90 bands. At present, however, these frequencies are extremely congested and, in the 174-216 MHz band, overly restrictive power levels compound the shortage of usable spectrum.

B. Frequency Congestion and Overly Restrictive Power Levels Make Operation in the 174-216 MHz and 512-566 MHz Bands Unusable. The 174-216 MHz band is severely overcrowded, and the level of ambient electrical noise in healthcare facilities is becoming so high as to threaten the continued usefulness of these channels, despite the fact that medical telemetry devices are extremely low-power and highly spectrum efficient.

Compounding the overcrowding problem is the fact that the current Part 15 mandated power levels for operation in the 174-216 MHz band are so low that even some manufacturers' current generation of ECG devices cannot be accommodated on these channels. For those manufacturers who do produce devices intended for operation in this band, the inability to increase power levels so as to compensate for the high level of background noise places at risk the viability of their operations and, in turn, patients' lives. Similarly, the Part 15 power levels applicable to operation on UHF-TV channels 21-29 are so restrictive that not a single member of the CCTG presently operates in this band.

C. Heavy Land Mobile Use of the 450-470 MHz Band Interferes With Medical Telemetry Operations. In light of the severe restrictions on power levels in the 174-216 and 512-566 MHz bands, many manufacturers, including HP and SpaceLabs, have elected to concentrate their telemetry operations on the offset

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[4] A summary of telemetry operations permitted under Part 90 of the Commission's Rules is set forth in the attached Engineering Statement.

channels in the 450-470 MHz band. Unfortunately, as the CCTG membership has demonstrated to the Commission in the past,[5] heavy use of this band by land mobile operations has caused severe interference to medical telemetry operations, interference which can have life-threatening consequences for patients whose vital signs must be monitored continuously.

Indeed, increased frequency congestion in the 450-470 MHz bands has made it difficult for hospitals to find usable frequencies for the operation of medical telemetry devices, and several hospitals already have requirements that exceed present channel capacity limits. HP alone spends thousands upon thousands of dollars on service calls to hospitals each year attempting to locate available frequencies and replace crystals in units accordingly.

While the Commission's proposals in the "refarming proceeding" are designed to increase spectrum efficiency in the private land mobile frequency bands below 512 MHz,[6] these proposals (and the proposals of other parties in the refarming proceeding), if implemented, would increase the already high level of interference to medical telemetry operations in the 450-470 MHz band.[7]

As HP and SpaceLabs explained in their comments in the refarming proceeding, expanding the number of potential non-medical telemetry users in the 450-470 MHz band, as proposed by the Commission, invariably would increase the likelihood of harmful interference to medical telemetry operations, particularly if new entrants employ digital systems that make more continuous use of the radio spectrum.[8] In the end, increased interference will force medical telemetry operations out of the 450-470 MHz band, notwithstanding the fact that these operations already meet, for all practical purposes, the efficiency standards proposed by the Commission for 2004.[9]

D. Immediate Action Must Be Taken to Assure Access to the Radio Spectrum for Medical Telemetry. In sum, the critical shortage of interference-free

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5 See Comments of HP at 5 (submitted May 28, 1993) and Comments of SpaceLabs at 6-7 (submitted May 28, 1993) in the Commission's "Refarm" Proceeding, PR Docket No. 92-235.

6 Notice of Proposed Rulemaking, PR Docket No. 92-235 (1992) at ¶ 1.

7 See, *e.g.*, SpaceLabs' Refarm Comments at 10-13.

8 HP's Refarming Comments at 5.

9 Id. at 3-4.

spectrum for the provision of essential, life-saving medical telemetry services seriously jeopardizes the continued provision of these services. This shortage will be exacerbated sharply when the second generation of medical telemetry devices comes on line, as these multifunction devices require an independent data stream for each separate function and, therefore, increased bandwidth.

In recognition of the urgent need for an interference-free home for medical telemetry operations, Congress, in connection with the passage of the Omnibus Budget Reconciliation Act of 1993, directed both the NTIA and the Commission to consider carefully the spectrum requirements of medical telemetry when allocating spectrum transferred from federal government to private sector use.[10] Unfortunately, because all of the frequencies under consideration for re-allocation are above 2 GHz, the spectrum being transferred is not suitable for medical telemetry operations.

The best solution for medical telemetry is to allocate dedicated frequencies for this purpose. Consistent with the Congressional directive, CCTG urges the Commission to study means other than the spectrum presently being reallocated from the federal government to accommodate the spectrum needs of medical telemetry. Nonetheless, to relieve the present critical shortage of adequate frequencies for medical telemetry, the Commission should increase the power levels presently allowed medical telemetry operating on vacant television channels.

III. MINOR AMENDMENTS TO THE COMMISSION'S RULES CAN ASSURE THE INTERFERENCE-FREE OPERATION OF MEDICAL TELEMETRY DEVICES WITHOUT CAUSING INTERFERENCE TO EXISTING OR PLANNED TELEVISION SERVICES

The shortage of usable spectrum for medical telemetry operations can be alleviated in the short term simply by permitting medical telemetry devices to operate on vacant upper VHF channels and all vacant UHF television channels at power levels not in excess of five (5) milliwatts. As proposed by CCTG, frequencies

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[10] The Conference Report to the Budget Act notes that "biomedical telemetry systems may greatly improve the quality and significantly decrease the cost of certain health care services," and that, therefore, "NTIA and the FCC should carefully consider the needs of hospitals and other health care providers for interference-free radio spectrum in their respective allocation decisions made pursuant to this Act." See Conference Report on the Omnibus Budget Reconciliation Act of 1993, 103d Cong., 1st Sess., Rpt. No. 103-213 (1993) at 479.

covered by this proposal would be those television channels currently allocated for medical telemetry operations (*i.e.*, channels 7-13; the 174-216 MHz band), as well as all other vacant UHF television channels.[11]

As demonstrated in the Engineering Study, operation of medical telemetry devices on vacant upper VHF channels and on all UHF television channels at power levels not in excess of 5 milliwatts will not cause harmful interference to television reception.

A. There Is No Risk Of Interference To Existing Television Reception. As the Engineering Statement points out, given that medical telemetry devices have very narrow bandwidths and extremely low effective radiated power levels, these devices will not cause harmful interference to reception of adjacent VHF or UHF television channels.[12] In order to prevent even the possibility of interference to co-channel television reception from medical telemetry devices under "worst case" engineering assumptions (*i.e.*, assumptions that tend to overstate the actual potential for interference), CCTG has developed minimum co-channel separation requirements (as described in detail in the Engineering Statement).[13]

These separation requirements are reflected in the proposed amendments to the Commission's Rules in Exhibit B, hereto. As described in the Engineering Statement, in order to implement the co-channel protection limits set forth in the proposed rule, telemetry devices operating at the new, higher power levels would be

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[11] Recently, the U.S. House of Representatives' Subcommittee on Information, Justice, Transportation and Agriculture held hearings concerning electromagnetic compatibility and medical devices. In his testimony before the Subcommittee, Dr. Thomas P. Stanley, Chief Engineer of the Commission's Office of Plans and Policy, stated that the optimum approach to avoid harmful interference to medical devices "is to make the medical devices more immune to undesired transmissions." (See Statement of Dr. Thomas P. Stanley, Chief Engineer of the Commission's Office of Plans and Policy, before the Subcommittee on Information, Justice, Transportation and Agriculture, Committee on Government Operations, U.S. House of Representatives, on Electromagnetic Compatibility and Medical Devices (October 5, 1994) at 5.) Such an approach is precisely what CCTG proposes herein: To overcome the harmful interference now jeopardizing medical telemetry operations by increasing modestly the maximum power output of medical telemetry devices, thereby making those devices less susceptible to interference.

[12] Engineering Statement at 4.

[13] Id. at 7-8. As set forth in Exhibit A, hereto, these co-channel separation requirements would apply only to medical telemetry devices operating at the increased power levels requested herein, and not to those devices that operate on vacant VHF and UHF television channels under the power levels currently set forth in § 15.241 of the Commission's Rules.

either frequency selectable, in which case trained field personnel would select the appropriate frequency of operation for a given hospital or medical facility in a particular geographic area, or the frequency would be pre-set by the manufacturer to correspond to a vacant TV channel in the geographic area in which the devices will operate.

Moreover, these low-power devices are used only inside the confines of health care facilities. This fact, as the Commission has recognized in the past, further reduces the potential for harmful interference to television services: on the one hand, compared with most other Part 15 devices, the confined use of medical telemetry devices would not result in the widespread distribution of potential sources of interference; on the other hand, restricting their operation to limited areas within a hospital building would provide a substantial, additional shielding effect.[14] Because television reception in hospitals is provided in most instances via cable, television receivers located on hospital grounds are entirely shielded from interference from telemetry transmissions.

To test the theoretical engineering assumptions concerning potential interference to television reception, a series of field measurements were conducted at hospitals using medical telemetry units manufactured by HP. The measurement results confirmed that the theoretical calculations did indeed represent a worst case scenario, as the HP units, in actual operation, had a much lower interference level than calculated.[15] Accordingly, provided that the co-channel separations criteria are observed, operation of medical telemetry devices on VHF and UHF television channels at power levels not in excess of 5 milliwatts will not result in harmful interference to existing television operations.[16]

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14 See Memorandum, Opinion & Order, 5 FCC Rcd 2723 (1990) at ¶ 15. See also Amendment of Part 18 of the Commission's Rules to Exempt Medical Ultrasonic Diagnostic and Monitoring Equipment from Technical Standards, 1 FCC Rcd 553 (1986), in which the Commission acknowledged that the operation of specialized medical equipment "in the typical hospital environments presents a minimal interference threat," id. at 553 [footnote omitted], and on that basis exempted a variety of devices from strict Part 18 compliance; and Exemptions from Computer Interference Rules, 60 R.R.2d 1479, 1481 (1986), reconsideration denied, 3 FCC Rcd 5143 (1988) (exempting a variety of medical test and research equipment from certain Part 15 regulations, based on a similar rationale).

15 See Conclusions Section of Appendix to Engineering Statement.

16 Engineering Statement at 10. Also, it is essential to bear in mind that, because medical telemetry operations are secondary to television licensees under Part 15, in the extremely remote event that a

(footnote cont'd on next page)

B. There Is No Risk Of Interference To Planned ATV Reception. While the Commission has not yet selected an Advanced Television ("ATV") system, it is highly unlikely that, in any given area of the country, no vacant television channels would exist. To CCTG's knowledge, no ATV proponent is advocating an ATV allocation scheme with no degree of co-channel and adjacent channel separation. Thus, even with the advent of ATV, there will always be vacant television channels on which medical telemetry devices can operate. Indeed, when authorizing medical telemetry devices to operate in the 512-566 MHz band, the Commission explicitly found that the operation of such devices in that band would not place at risk the forthcoming ATV system.[17]

Moreover, as the Engineering Statement points out, the "Grand Alliance" of U.S.-sponsored all-digital advanced television systems recently selected a transmission system developed by Zenith Electronics Corporation. Based on the parameters for interference potential to the Zenith system contained in the Grand Alliance HDTV System Specification, submitted to the Advisory Committee on Advanced Television Services on February 22, 1994, the Zenith system would be substantially more immune to interference than existing television operations.[18]

In short, because vacant television channels would exist under any ATV allocation scheme the Commission ultimately adopts, and in light of the fact that the ATV system now under consideration is actually more interference resistant than current television operations, operation of medical telemetry devices in the manner proposed herein will not interfere with planned ATV reception.

IV. CONCLUSION

A serious shortage of usable spectrum has placed at risk the continued viability of medical telemetry services and, in turn, the safety of patients that rely on the interference-free provision of these services. This risk is heightened by the increased spectrum requirements of the next generation of enhanced medical

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telemetry device interfered with television reception, the licensee of that device would be required to discontinue use of the device or take other measures to correct the interference problem.

17 See, Memorandum, Opinion and Order, 5 FCC Rcd 2723 (1990) at ¶15.

18 Engineering Statement at 10-11.

telemetry devices demanded by the medical community, as well as by the impending implementation of one or more of the proposals now under consideration in the Commission's refarming proceeding.

Fortunately, until dedicated frequencies are found for medical telemetry devices, a workable stop-gap solution exists. As set forth above, by authorizing the operation of medical telemetry devices at power levels not in excess of 5 millimeters on vacant upper VHF channels and on all UHF television channels, the Commission can accommodate the present and future spectrum requirements of medical telemetry without risking harmful interference to existing or planned television reception.

In light of the essential, life-saving functions that these devices perform, adoption of the amendments to the Commission's Rules proposed herein would substantially advance the public interest. Accordingly, CCTG urges the Commission to issue the Notice of Proposed Rule Making requested herein on an expedited basis.

Respectfully submitted,

CRITICAL CARE TELEMETRY GROUP

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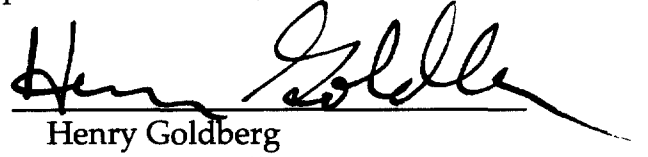
By: 

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December 23, 1994

EXHIBIT A

ENGINEERING STATEMENT
IN SUPPORT OF A PETITION FOR RULE MAKING
CONCERNING OPERATION OF
BIOMEDICAL TELEMETRY DEVICES
ON UNUSED TELEVISION CHANNELS

I, Robert A. Bednarek, hereby certify: that I am a principal in the firm of Rubin, Bednarek & Associates, Inc., consulting telecommunications engineers with offices in Washington, DC; that I hold a Bachelor of Science degree in Electrical Engineering from the University of Florida; that I am thoroughly familiar with the Rules and Regulations of the Federal Communications Commission governing the use of the electromagnetic spectrum; and that I have provided engineering services in the area of telecommunications since 1973. My qualifications as an expert in radio engineering are a matter of record with the Federal Communications Commission.

The firm Rubin, Bednarek & Associates, Inc., has been retained by the Critical Care Telemetry Group ("CCTG"), a group representing virtually all of the manufacturers of biomedical telemetry devices, to undertake a comprehensive engineering study to support the use of such devices within the VHF and UHF television broadcast bands. This statement documents the results of this study and provides technical support for a Petition for Rule Making to permit the operation of select biomedical telemetry devices on unused television channels within the 174-216 MHz band (television channels 7-13) and the 470-608, 612-806 MHz bands (all UHF television channels except for channel 37) at transmitter power output levels not in excess of five milliwatts. As demonstrated herein, the use of frequency sharing among the proposed biomedical telemetry devices and television stations can be achieved without any harmful interference being caused to the reception of the television signals, while improving the reliability of biomedical telemetry.

I. Introduction

Biomedical telemetry devices currently may operate under the provisions of either Part 15 or Part 90 of the FCC Rules. Devices authorized under Part 15 are permitted to transmit in portions of both the VHF and UHF television bands. Operation within the VHF-TV band (174-216 MHz; channels 7-13) is governed by §15.241 of the Rules and emissions must be confined within a 200 kHz bandwidth and radiated field strengths are limited to no greater than 1500 μV/m, measured at a distance of 3 meters from the device. Similarly, operation within the UHF-TV band (512-566 MHz; channels 21-29), is permitted under §15.209(a) & (g). In this instance, radiated field strengths are limited to no greater than 200 μV/m, measured at a distance of 3 meters from the device.

In addition to the frequencies permitted under Part 15, operation of biomedical telemetry devices is also permitted on select frequencies as delineated in Part 90 of the Rules. In general, Part 90 allows the utilization of higher transmitting power levels than the emission

level limitations of Part 15 permit. Part 90, however, places a wide variety of restrictions on the use of the devices and the specific frequencies which can be utilized. As summarized in the attached Table 1, in many cases biomedical telemetry use of Part 90 frequencies is on a co-equal (or secondary) sharing basis with other users, typically land mobile applications and other non-telemetry transmissions. In some instances, higher ambient noise levels result from these operations.

As discussed more fully below, the emission limitations under Part 15 and the required frequency sharing under Part 90 limit the effectiveness and reliability of biomedical telemetry operations. If the Commission's proposals to "refarm" the spectrum used by the private land-mobile radio services are adopted, interference to biomedical telemetry devices will increase.

As documented in this Statement, CCTG proposes to permit the limited operation of biomedical telemetry devices within the VHF and UHF television bands consistent with operations presently permitted under Part 15 of the Rules. However, in order to increase the operational reliability and utility of the telemetry devices, an increase in the maximum radiated emissions now permitted under Part 15 is sought. As demonstrated herein through engineering analysis and field measurements, this proposed increase in the level of permitted emissions will not result in any harmful interference to the reception of existing or future VHF or UHF television stations.

II. Technical Characteristics of Biomedical Telemetry Devices

Part 90 of the FCC Rules defines telemetering (also telemetry) as the transmission of non-voice signals for the purpose of automatically indicating or recording measurements at a distance from the measuring instrument. A biomedical telemetry device is defined in Part 15 as an intentional radiator used to transmit measurements of either human or animal biomedical phenomena to a receiver. The devices addressed herein currently consist of a pocket-sized transmitter with patient electrode cables, a distributed active receiving antenna system, a companion receiver, and a computer monitoring station. The electrode cables also serve as the antenna for the transmitter.

The telemetry transmitter sends digitized electrocardiogram (ECG) signals to the remote monitoring equipment which displays diagnostic-quality ECG waveforms or heart rate, detects and analyzes cardiac arrhythmia's, and displays alarm conditions. Although less common, oxygen saturation, non-invasive blood pressure and other parameters also may be monitored. (See Figure 1)

Depending on the manufacturer, these devices employ various types of digital modulation such as PM/BPSK, Binary NRZ FSK, or GMSK. The occupied bandwidth can vary from 10 kHz to 100 kHz depending on the modulation type and the data rate. However, regardless of the power spectrum of the input source waveform, the modulating waveform is generated as a randomized digital signal with a constant power spectrum. Figure 2 shows typical output spectra for existing devices in both UHF and VHF bands.

Due to the small geometry of the biomedical telemetry transmitter antenna, antenna gains typically range from -20 dBi to +3 dBi. The 3 dB antenna gain is achieved only by using a

table top antenna. In typical operation, the antenna is made up of the shields of four electrode cables, each approximately two feet in length and grouped randomly together with several inches apart. The gain of this typical antenna configuration is nominally found by the manufacturers to be approximately -20 dB across the VHF and UHF spectrum, with no significant or repeatable directional characteristics. Several models of existing systems operate at VHF frequencies under the provisions of §15.241 and others at UHF frequencies under the provisions of §90.238(e). The VHF based systems typically generate a field strength of 150 μV/m at 30 meters (1500 μV/m at 3 meters). Transmitter power output (TPO) is typically on the order of -30 dBm (0.001 mW). At UHF frequencies, a typical value for the radiated field strength at 30 meters would be 8000 μV/m (80,000 μV/m at 3 meters). At UHF frequencies a TPO of 3 dBm (2 mW) is typically required to generate this field strength level.

The telemetry transmitter is activated when its batteries (commonly either 9-volt or two 1.5-volt AA alkaline cells) are inserted and transmits continually until the batteries are removed, even when the electrode cables are not connected to a patient. There is no on/off switch. Nominal battery life is 1.5 to 8 days depending upon the type of battery employed.

III. Current Biomedical Telemetry Operations

The emission limitations under Part 15 restrict the geographic range over which telemetry devices can operate and still overcome ambient noise reliably. This is especially true in the UHF television band where sufficient power to overcome broadcast and land mobile generated noise is not currently authorized. Indeed, there are no known biomedical telemetry systems of the type discussed herein which operate in the UHF television band under the current provisions of Part 15 (operation is limited to that under Part 90). Another significant problem caused by the very low power used by these devices is the inability to overcome multipath fading, which results in 20-40 dB fades and relatively little reinforcement of the telemetry signal.

As noted previously, these devices provide 24-hour monitoring of cardiac and other intensive care patients while giving these patients the freedom to be mobile, in the absence of other constraining factors. Depending on the types of treatment required, a patient may need to be taken to locations in the hospital some distance from his or her room. Because of the critical nature of the monitoring being provided, the radio link between the transmitter worn by the patient and the stationary receiver must be highly reliable. When the telemetry radio range in limited, either the patient's movements must be restricted or the monitoring function compromised.

Table I summarizes telemetry operation permitted under Part 90. Under Part 90 operation, frequencies are shared with land mobile users. Because of the transient nature of the sharing users, there is significant potential for the biomedical telemetry devices to be subjected unexpectedly to intermittent strong unwanted signals on the same or nearby frequencies. Furthermore, when the biomedical telemetry devices contain multifunction capabilities (sending two or three measurements from one individual at once), the bandwidth requirements in Part 90 are too stringent. Because of the extremely critical nature of the function these devices perform, the signaling employed must be highly robust, in order to reduce the likelihood of harmful interference occurring. The need to rechannel existing telemetry devices because of new sources of received interference from other Part 90 users is an ongoing problem. The net result is greater device cost and generally increased medical expenses.

Most current UHF biomedical telemetry systems operate under licenses in the Business Radio Service on the so-called 12.5 kHz split channels (§90.238(e)). At present, other users of these channels must operate with less power than is permitted on the regular 25 kHz-spaced land mobile channels. As changes proposed in the FCC's "refarming" proceeding (PR Docket No. 92.235) are implemented, however, higher power operation will be permitted on the 12.5 kHz -spaced channels. If, ultimately, 6.25 kHz (or 5 kHz) channeling is implemented, it is possible that several interfering land mobile users could operate simultaneously within a single existing telemetry channel. Under this scenario, existing interference problems resulting from frequency sharing with mobile users may increase.

Given the difficulties encountered with operation under current Part 15 and Part 90 frequencies and operating restrictions, CCTG proposes that medical telemetry devices be permitted to operate on all vacant channels within the upper VHF and all vacant UHF channels at transmitter power output levels not to exceed five (5) milliwatts. Telemetry devices would be frequency selectable, and trained field personnel would select a vacant channel for operation of the device for a given medical facility, or alternatively, would be manufactured so that frequencies would be pre-set and correspond to a "vacant" television channel in a particular geographic area. Channel selection criteria will be established on the basis of existing co-channel interference protection standards found in Part 73 and Part 74 of the Rules in order to insure that a device will always operate on a frequency outside of the 6 MHz channel employed by any locally-viewed station.

Given the very narrow bandwidths and low effective radiated powers of the telemetry carriers, operation on a first-adjacent channel will not cause harmful interference to a television receiver, even one in close vicinity to a biomedical telemetry transmitter. Coupled with the controlled, institutional use of these devices, use of non co-channel television channels represents an ideal increase in overall spectrum efficiency. Because television station transmitters are licensed at fixed locations, proper selection of the frequencies to be employed for biomedical telemetry purposes at a given location will eliminate any potential for harmful interference from these devices.

IV. Other Services Sharing the VHF and UHF Television Bands

The FCC has long recognized the feasibility of other radio services sharing the VHF and UHF television bands on a non-interference basis. Currently, the most extensive sharing involves the operation of land mobile stations on TV channels 14 through 20 in certain urban areas; this was authorized by various Report and Orders (issued from 1970 through 1974) in FCC Docket No. 18261. Additional sharing of the 470-512 MHz television band with land mobile operations, in the New York and Los Angeles urbanized areas, was authorized by a Report and Order (issued in 1974) in FCC Docket 20109. (See §22.501(j) &(k) for rules governing operation on these frequencies.)

Because the proposed biomedical devices operate at power levels greatly reduced compared with land mobile stations, it is unlikely that interference would be caused to land mobile stations operating on UHF-TV channels 14-20. Furthermore, operators of biomedical telemetry devices will avoid channels in use by land mobile services in order to not receive interference. It should be noted that low power auxiliary stations, discussed below, operate on these land mobile channels at power levels much greater than the power level that requested herein with no known cases of interference caused to the land mobile service.

In 1982, the Commission instructed the Office of Science and Technology to evaluate the feasibility of further sharing of the UHF television band by land mobile services; a report was published in October 1983 (FCC/OST R83-3) entitled "Analysis of Technical Possibilities for Further Sharing of the UHF Television Band by the Land Mobile Service in the Top Ten Land Mobile Markets." Among other results, this study established a methodology for calculating the interference protection which must be afforded both full-power stations and LPTV stations from the lower-power, narrowband land mobile transmissions.

Although the land mobile service involves the most extensive sharing of the television band, it is by no means the only other radio service permitted to operate in the television bands on a non-interference basis. As noted earlier, Part 15 permits operation of biomedical devices in portions of television bands. Part 15 also permits the operation of perimeter protection systems within the lower two portions of the VHF television band (54-72 MHz and 76-88 MHz) and periodic devices meeting certain emission limits in portions of both the VHF and UHF television bands.

Under Part 74, low power auxiliary stations (LPAS), which are primarily employed as wireless microphones, have long been permitted to operate in the 174-216 MHz band (high-band VHF-TV channels 7-13). By Report and Order in MM Docket No. 86-12 (released January 16, 1987), the Commission expanded the permissible sharing to include the low-band VHF-TV channels 2-6 (54-72 MHz and 76-88 MHz) and the UHF-TV channels 14-69 (470-806 MHz), except for channel 37 (608-614 MHz) which is reserved for radio astronomy purposes.

In the Report and Order in MM Docket No. 85-36 (released November 7, 1985), the Commission authorized, on a secondary basis, operation of TV STL/ICR stations on UHF-TV channels 14-69. The protection criteria specified in Part 74, Subpart G, regarding low power TV and TV translator stations, are used to ensure that no harmful interference is caused to existing television stations. For protection to existing land mobile stations operating under Part 90, Subpart L of the Rules, the criteria specified in §74.709 are applied.

Throughout the Commission's numerous proceedings regarding the sharing of the VHF television band and the UHF television band, consistent reliance has been placed on well established methodologies for the determination and calculation of interference potential. While the allocation and location of a full power television station are governed by simple distance separation criteria, virtually every subsequent and additional broadcast and non-broadcast use of the UHF and VHF bands has been considered on the basis of calculated desired-to-undesired (D/U) ratios and corresponding estimates of the levels of harmful interference[1].

Existing sharing of the television bands which most closely parallels the instant proposal is by LPAS, or wireless microphones. In LPAS, the only restrictions are that operation be at least a certain minimum distance from any co-channel television station, that the total bandwidth not exceed 200 kHz, and that transmitter power output not exceed 50 milliwatts for VHF frequencies and 250 milliwatts for UHF frequencies. The Commission has noted the absence of harmful interference caused by LPAS devices, even though LPAS power levels are at least ten times higher than those proposed herein for biomedical telemetry purposes.[2]

V. Analysis of Potential Interference from Biomedical Telemetry Devices to Television Reception

Part 73 provides methods for estimating television field strengths under particular conditions and at various distances from transmitting stations. Part 74 of the Rules, which governs the location and licensing of low power television stations, contains a comprehensive articulation of the actual D/U ratios required to protect television viewers from harmful interference, and provides appropriate method for applying these D/U ratios. The ratios specific to co-channel and adjacent channel operations are tabulated in the attached Table 2. Using these established criteria, CCTG now demonstrates that operation of biomedical telemetry devices at the increased power levels proposed will not cause harmful interference to existing full power television operations. It is also

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[1] In these instances, distance separation criteria have been limited to concerns with the so called intermodulation, IF beat, and oscillator taboos in the UHF band. These taboos have not been considered of primary concern when the proposed sharing service has been relatively low power and non-broadcast in nature (e.g., LPAS).

[2] In its *Notice of Proposed Rulemaking* (NPRM) in MM Docket 86-12, the Commission stated that "Since their [LPAS] entry into this band [high VHF-TV], in 1977, interference to television stations has not increased as best we can determine. The Commission is not aware of any complaints regarding LPAS use of these frequencies. The absence of interference is largely attributable to the fact that LPAS receivers are much more susceptible to interference from broadcast TV signals than *vice versa*." NPRM at para. 4.

demonstrated in this section that more-conservative free-space field strength propagation predictions are not appropriate for this analysis as they are overly protective.

Use of the biomedical telemetry devices which are the subject of this statement will be limited to hospitals and similar institutions where patients require continuous 24 hour monitoring of various vital signs. Television reception on hospital grounds would be under the control of the hospital administration as is the use of the biomedical telemetry devices. In addition, in today's modern hospitals, television reception is generally via cable and hence would be shielded from potential interference from the telemetry signals. Consequently, the instant analysis of potential interference from biomedical telemetry devices to television reception will be limited to television receivers located off hospital grounds. (See Figure 3)

The biomedical telemetry devices proposed herein for use in the television bands would employ a maximum TPO of 7.0 dBm (5 mW) or less. Based on an assumed maximum antenna gain of 3 dB, the maximum effective radiated power will be 10 dBm (10 mW).

This proposed TPO level can be compared with TPO levels typically employed by today's biomedical devices: -30 dBm (1 μW) for the VHF band, and 3 dBm (5 mW) for the UHF band. These power levels can also be compared with TPO levels for LPAS: 17 dBm (50 mW) for the VHF band, and 24 dBm (250 mW) for the UHF band.

Based upon the co-channel and adjacent-channel D/U ratios shown in Table 2, a series of calculations have been made to determine the radius of potential interference at the Grade B contour of each category of TV station. For the purpose of these calculations, operating parameters for the television stations were assumed to be the following maximums.

The following assumptions are employed:

1) Maximum effective radiated power (ERP) and antenna height above average terrain (HAAT) for TV operation.

2) Telemetry operation at 5 mW TPO and maximum antenna gain of 3 dB for an ERP of 10 mW (10 dBm). Telemetry antenna HAAT of 30.5 meters.

3) Propagation for both TV and telemetry operations predicted using §73.699 Figure 10 for high-band VHF, and §73.699 Figure 10b for UHF. These are F(50,50) predictions, which are suitable for the interfering telemetry signal in this case as time variation is negligible for such short interfering distances. As discussed below in the section on field verification, a free-space propagation model inappropriately overstates the extent of telemetry propagation.

4) The television station Grade B contour is considered "protected" for the purposes of this analysis. Co-channel television stations under typical operation, however, especially those operating at or near maximum height and power, can cause substantial interference to each other's Grade B service area.

5) The proposed separation between co-channel TV and telemetry facilities is calculated by adding the distances of the TV Grade B contours to the telemetry interfering contours.

Table 3 shows the intermediate calcuation results for this analysis. The resulting proposed distance separations between co-channel TV and telemetry devices is as follows:

TV Facility	Proposed Separation (km)
High-Band VHF -- Zone I	107.1
High-Band VHF -- Zone II and III	131.8
UHF	113.2

From Table 3, it can be seen that the 11 dBu high-band VHF interfering contours extend 11.4 kilometers, and the 19 dBu UHF interfering contours extend 6.1 kilometers based on FCC propagation curves. Free-space field strengths at those distances are 33.6 dBu and 39.1 dBu, for VHF and UHF, respectively; they are about 20 dB higher than field strengths computed using the FCC's curves. Based on measurements discussed below, a building penetration loss factor of at least 20 dB should be applied to reflect the real-world environment. When this factor is applied to the free-space calculations, the distances to the interfering contours are near those computed using the FCC's propagation curves.

The above analysis relates to the co-channel interference analysis. Adjacent-channel interference concerns are subsumed by the co-channel analysis, as now explained -- first for the UHF case, and then for the high-band VHF case.

At the UHF Grade B, 64 dBu contour, an adjacent-channel interfering contour would be 79 dBu (64 dBu plus 15 dB). Using free-space calculations, the distance at which a telemetry transmitter could produce a field strength of 79 dBu is 61.5 meters. Considering a building penetration loss of 20 dB, the distance to the 79 dBu contour is 6.2 meters. At the high-band VHF Grade B, 56 dBu contour, an adjacent-channel interfering contour can be as low as 62 dBu (56 dBu plus 6 dB). The distance at which a telemetry transmitter would produce a field strength of 62 dBu is 435 meters. Considering a nominal building penetration loss of 20 dB, the distance to the 62 dBu contour is 43.5 meters. From this adjacent channel discussion, it may be concluded that operation of the biomedical devices as proposed herein can be accommodated by considering protection only to co-channel stations.

Secondary services such as low power television (LPTV) and studio-transmitter links (STLs) operating in the VHF and UHF television bands are unlikely to be adversely affected by the instant proposal. LPTV stations have greatly limited coverage compared with full-service stations. Furthermore, hospitals would avoid using frequencies of nearby LPTV stations in order to not cause interference to their biomedical devices. STLs use highly directive antenna systems which reduce the ability to receive harmful interference. Any interference problems that might be caused by biomedical telemetry devices can be resolved by retuning the devices.

To reiterate, CCTG proposes that biomedical devices be authorized in the upper VHF channels and all UHF television channels with 1) a transmitter power output not exceeding

5 milliwatts, and 2) not authorized closer than 107.1 kilometers to a high-band VHF television station in Zone I, 131.8 kilometers from a high-band VHF television station in Zones II and III, and 113.2 kilometers from any UHF television station. These separations will place the biomedical devices well outside the coverage range, and hence available viewing area, of a station operating on the same frequency.

It should be noted that these proposed distances are equal to or more restrictive than those restricting LPAS (wireless microphone) operation.[3] Moreover, the 5 mW TPO requested herein is 10 dB below the maximum power permitted LPAS operation in the VHF band (50 mW), and 17 dB below the maximum power permitted LPAS operation in the UHF band (250 mW).

In order to effect the co-channel protection limits specified above, CCTG proposes the manufacturing and distribution of frequency selectable devices or devices that are pre-set to correspond to a vacant channel for a given hospital in a given geographic area. Frequency selectable telemetry transmitters will be manufactured with a range of available frequencies (e.g. channels 20-29) and would be set depending on the specific location of operation. Field personnel would be trained to open these frequency selectable units and set the frequency of operation to a selected channel meeting the distance separation criteria listed above. In the event that any unpredicted or unforeseen interference is experienced, the units could quickly be retuned to another of the available frequencies (subject to verification and approval).

VI. Field Verification and Propagation Analysis

To investigate further the potential for the proposed biomedical telemetry operations to cause interference, a series of field measurements were undertaken to gather actual operating data for comparison with theoretical calculations. A complete report on the measurement survey is included in the attached Appendix. Figure 4 shows a plot of the measured telemetry field strength values as a function of distance from the telemetry unit. A theoretical free-space field strength curve also is plotted for reference. From the graph it is clear that the general trend in the telemetry field strength values conforms with the same inverse distance relationship as for free-space assumptions (at short distances). However, (except for a few cases) the median telemetry field strengths are approximately 20 dB below those predicted based on free-space assumptions. This attenuation is comparable to that found in propagation literature.[4] At distances greater than 10 meters from the telemetry transmitter, the median measured field strengths are approximately 30 dB lower than free-space predictions.

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[3] See §74.802(b). Comparable distances in that rule are, for high-band VHF, 97 kilometers in Zone I, and 129 kilometers in Zones II and III; for all UHF, 113 kilometers.

[4] A 20 dB building penetration loss for VHF is also found in L.P. Rice, "Radio Transmission into Buildings at 35 and 150 mc," The Bell System Technical Journal, January 1959, page 204, Figure 5. Building attenuation will be greater at VHF than at UHF frequencies for the types of building structures used by most hospitals; see Allen Davidson and Raymond Marcario letters to the editor, IEEE Vehicular Technology Society News, August 1994, pages 7,8.

For the measurements made at distances of 3 meters or less, an unobstructed path usually existed between the telemetry unit and the antenna connected to the spectrum analyzer. At the greater distances such unobstructed paths were generally not attainable and the amount and type of obstruction varied for each telemetry unit (i.e. frequency) measured. This was one of the causes of the wide scattering observed in the measurements taken at the middle range of distances shown in Figure 4. A further cause of the scattering was multipath interference resulting from signal reflections off of nearby surfaces. In-phase additive multipath reflections are the most likely cause of the few anomalous high readings observed.

The four most distant measurements show no scatter and are approximately 35 dB below free-space values. These particular measurements were taken across the street from the Mercy Medical Center. The telemetry signals had to pass through that portion of the hospital building between the eighth floor where the telemetry units were located and street level where the measurement equipment was set-up. The magnitude of the path obstruction was greater than for inside measurements and most other outside measurements. The change from unit-to-unit in the nature of the obstruction would be relatively minor. Also, there were no nearby structures to create multipath effects. These factors are believed to be the cause of the increased attenuation relative to free-space and the lack of scatter.

The measurement data supports the conclusion that as long as the above separations are maintained with respect to co-channel television stations, operation of biomedical telemetry devices in the television bands would not result in any harmful interference to co-channel or adjacent-channel television reception.

Even though measurements were performed at UHF frequencies only, it can be concluded that VHF attenuation caused by hospitals would be greater, as building loss generally increases from UHF to VHF for the types of structures used by hospitals.[5]

VII. Impact on Advanced Television

The FCC has not chosen a final set of specifications for the transmission of an Advanced Television (ATV), or high-definition television (HDTV) signal. However, earlier this year the Grand Alliance of U.S.-sponsored all-digital advanced TV systems (G-A) selected the 8-VSB (vestigial sideband scheme) transmission subsystem developed by Zenith Electronics Corporation. The Advanced Television Test Center (ATTC) is responsible for testing this system. Implementing the G-A 8-VSB system will require, for each TV broadcast station, a separate 6-MHz channel in addition to the existing 6-MHz channel used for NTSC transmission.

A document entitled "Grand Alliance HDTV System Specification" was submitted to the Advisory Committee on Advance Television Services (ACATS), February 22, 1994. Chapter VIII of that document contains a table listing parameters for the projected typical performance of prototype 8-VSB equipment. These parameters include information on interference potential. D/U ratios are provided for interference from one HDTV signal to

[5] Id.

another as well as for interference from an NTSC signal to an HDTV signal. Compared to NTSC, the proposed HDTV system will be much more resistant to interference, whatever the source. Table 4 shows a comparison between the co-channel and adjacent channel protection ratios used for the current NTSC system and those projected for the proposed HDTV system. The less restrictive D/U ratios for both NTSC-to-HDTV and HDTV-to-HDTV interference protection imply that the potential for the proposed biomedical telemetry units to interfere with the proposed HDTV service is even less than the potential for interference to the existing NTSC service.

Because of the limited potential for interference combined with the limited and specialized environment wherein these telemetry devices would operate, authorization of frequency sharing in the television bands by biomedical telemetry devices would not have any preclusive impact on the implementation of a new HDTV service.

VIII. Conclusions

The current provisions in the FCC Rules which govern the operation of biomedical telemetry devices are insufficient to meet the demands for these devices. The present permissible emission levels and required spectrum sharing limit the utility and reliability that can be achieved. As the ambient electrical noise levels in hospitals and other medical facilities increase, the problem will become more severe. Likewise, as a result of the FCC's "Refarming" proceeding, the potential for these telemetry devices to receive harmful interference will also increase. Because of the critical nature of the vital sign monitoring performed by these devices, it is necessary to ensure a reliable and interference free radio channel. Enhanced reliability can be achieved by permitting limited sharing of the broadcast television band. As has been demonstrated, biomedical telemetry devices of the type discussed herein, operating with a TPO of no greater than 5 mW, would not cause any harmful interference to the reception of television broadcast signals. Operation at this increased power level would help to combat increasing ambient noise problems. Since the broadcast television service employs fixed transmitter sites, operating frequencies for the telemetry devices can be selected to minimize the interference potential on a more definite basis.

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TABLE 1

Summary of Telemetry Operation Permitted Under Part 90 of the FCC Rules		
Rule Section	**Frequency(ies) in MHz**	**Limitations**
90.27(c)(4)	155.325, 155.340, 155.355, 155.385, 155.400	F1B, F1D, F2B, or F2D emissions only[1]. Cannot be used in the top 50 urbanized areas. Non-telemetry use of these frequencies also permitted.
90.27(c)(9)	463.075, 463.100, 463.125, 463.150, 463.175, 468.075, 468.100, 468.125, 468.150, 468.175	Continuous carrier mode of operation permitted for telemetry transmissions. Non-telemetry use of these frequencies also permitted.
90.27(c)(20)	463.000, 463.025, 463.050, 468.000, 468.025, 468.050	These frequencies used only for biomedical telemetry station operations. F1B, F1D, F2B, F2D, F3E, G1B, G1D, G2B, G2D, or G3E emissions only[2].
90.27(c)(26)	453.025, 453.075, 453.125, 453.175, 458.025, 458.075, 458.125, 458.175	F1B, F1D, F2B, F2D, F3E, G1B, G1D, G2B, G2D, or G3E emissions only[2]. Non-telemetry use of these frequencies also permitted.
90.75(d)(4)	Offset 12.5 kHz from standard channels in the 460.650-460.875 and 465.650-465.875 bands	100 mW or less output power for one-way, non-voice biomedical telemetry operation in hospitals, etc.
90.238(a) & 90.257	72-76 band	Vertical polarization only. No harmful interference to VHF television channels 4 and 5.[3]
90.238(b)	154.45625, 154.46375, 154.47125, 154.47875	Not allocated to emergency medical or special emergency services. Remote control usage permitted.[3]
90.238(c)	173.20375, 173.2100, 173.2375, 173.2625, 173.2875, 173.3125, 173.3375, 173.3625, 173.3900, 173.39625	Not allocated to emergency medical or special emergency services. Remote control usage permitted.[3]
90.238(d) & 90.259	216-220 and 1427-1435 bands	These frequencies used only for telemetry operations under Part 90, but usage is secondary to Federal Government operations, maritime mobile service (216-220) and space operation service (1427-1429).
90.238(e) & 90.267	Offset 12.5 kHz from standard channels in the 450-470 band	Non-telemetry use of most of these frequencies is permitted. Only 460.650-460.875 and 465.650-465.875 bands restricted to biomedical telemetry usage.
90.238(f) and Subpart T	220-222 band	PCS band - would not be suitable for biomedical telemetry use.
90.238(g) & 90.261	450-470 band	Fixed operation only and on a secondary basis.[3]
90.238(h)	458-468 band	None of these frequencies allocated only for biomedical telemetry.

[1] Continuous carrier mode of operation may be used for periods up to two-minutes duration; following which there must be a break in the carrier for at least a one-minute period.

[2] Continuous carrier mode of operation permitted under §90.27(c)(9).

[3] These frequencies are not restricted to only biomedical telemetry, but may be used by other types of telemetry devices.

TABLE 2

Established Interference Protection Criteria in the VHF and UHF Television Bands		
Channel Relationship	**VHF Band**	**UHF Band**
Cochannel	45 dB D/U	45 dB D/U
Upper 1st adjacent channel	-6 dB D/U	-15 dB D/U
Lower 1st adjacent channel	-12 dB D/U	-15 dB D/U
2nd adjacent channel	---	32 km separation
3rd adjacent channel	---	32 km separation

TABLE 3

Intermediate Calculation Results Leading to Proposed Separation Distances

TV Facility Max. ERP Max. HAAT	Grade B Contour	Predicted Distance to Grade B Contour	Telemetry Interfering Contour	Predicted Distance to Telemetry Interfering Contour	Proposed Separation between Co-channel TV and Telemetry
High-Band VHF Zone I 316 kW 304.8 m	56 dBu	95.7 km	11 dBu	11.4 km	107.1 km
High-Band VHF Zone II Zone III 316 kW 609.6 m	56 dBu	120.4 km	11 dBu	11.4 km	131.8 km
UHF 5000 kW 609.6 m	64 dBu	107.1 km	19 dBu	6.1 km	113.2 km

TABLE 4

Comparison of Interference Protection Criteria Between Existing NTSC and Proposed HDTV Television Services				
Channel Relationship	**Existing NTSC**		**Proposed HDTV**	
	VHF Band	**UHF Band**	**HDTV/HDTV**	**NTSC/HDTV**
Cochannel	45 dB D/U	45 dB D/U	16 dB D/U	2.5 dB D/U
Upper 1st adjacent channel	-6 dB D/U	-15 dB D/U	-40 dB D/U	-45 dB D/U
Lower 1st adjacent channel	-12 dB D/U	-15 dB D/U	-40 dB D/U	-45 dB D/U
2nd adjacent channel	N/A	32 km separation	N/A	N/A
3rd adjacent channel	N/A	32 km separation	N/A	N/A